## REMARKS

Claims 5 and 6 have been amended and remain in the application. Reexamination and reconsideration of the application, as amended, are requested.

Claims 5 and 6 were rejected as unpatentable over claims 7-9 of U.S. Patent No. 6,342,182. A Terminal Disclaimer is submitted herewith to overcome this rejection.

Claims 5 and 6 were further rejected under 35 U.S.C. 103(a) as being unpatentable over Fujimoto (JP 09-078160) in view of Kashiwagi (JP 09-184033) and Steinke et al (U.S. 5,240,172). Claim 5 has been amended to overcome these rejections.

Claim 6 has been amended to correct a typo.

Even if the addition of Ga and In is known from one having ordinary skill in the art, Fujimoto (JP 09-078160) does not comprise such elements and both of cited examples are not at all suitable to be used as alloys in lost-wax casting techniques. Moreover, only one example comprises less than 13.5% by weight Pd but it comprises more than 10%Cu. The other example comprises 15% by weight Pd and 10% Cu. It was not surprising to obtain a white gold alloy with 15% Pd. On the other hand, it was not at all obvious to reduce the content of Pd between 12.5% and 13.5% by weight without adding of Ag which generates a tarnishing of the alloy.

From Fujimoto, it clearly appears that it was not at all obvious to discover that a very narrow gap exists between 12.5% and 13.5% Pd, but with no more than 10% Cu, leaving between 1.5% and 2.5% by weight for adding In and Ga as well as few proportions of Ir, Re, Zn, Nb, Si, Ta and Ti. It was not surprising that the addition of these elements improve the metallurgical properties of an alloy to be used in lost-wax casting techniques. However, it was not at all obvious to obtain with 13% Pd and 10% Cu a grey alloy having a colour near than that of rhodium, since in jewelry, the rhodium is plated on the grey gold alloy in order to improve the

glitter of stones. Such a grey alloy so leaves still 2% by weight for adding the above-mentioned elements. The non obviousness of this invention was not that the applicant has added well known elements for improving the metallurgical properties of the alloy to be used in lost-wax casting techniques, but that with only 12.5% to 13.5% by weight Pd and no more than 10% Cu without adding Ag, the colour of the alloy is so close that of rhodium which is the reference for the jewelry as explained above.

Applicant has discovered a narrow gap allowing to obtain a grey alloy without Ni having a colour feature and metallurgical properties practically perfect for an alloy to be used in lost-was casting techniques.

The applicant has made comparative tests of casting by lost-was technique with the example 12 of table 1 of the claimed invention and both examples of Fujimoto. In a frame at the top right of the sheets is indicated to which example relate the graphs and photographs. The two first pages are explanations relating to the measure of colour in Lab co-ordinates according to the normalization from the international Comity on Illumination CIE. "Table 1 composition 12" relates to a sample made according to example 12 of the application. "JP1" and "JP2" relate to samples made respectively according to both examples of Fujimoto. These photographs obviously show the well better quality of the sample according to example 12 of the present application. The graphs according to Lab co-ordinates show that the samples according to JP1 and JP2 are nearer the colour of a Pt 95% by weight sample as claimed by Fujimoto than that of rhodium, which is the reference for a grey gold alloy for jewelry. The colour of Rh is also indicated on these graphs.

The tests of casting by lost-wax technique show that for similar liquidus values (completely melt alloy) the casting behavior does not give a fine aesthetic result which is

requested by the jeweler.

The metallographic sections and Lab co-ordinates graphs show that the metallurgical properties and the colour of the alloy according to the present invention are substantially improved with respect than the alloy of Fujimoto and that the claimed alloy is especially well suitable for jewelry applications. It clearly appears from the above explanations that the very narrow gap claimed by the applicant correspond to a surprisingly well adapted solution to solve the problem of a grey gold alloy with 75% by weight Au without Ni to be used in the lost-wax casting technique for the jewelry field.

In view of the above, it is believed that all claims are now in condition for allowance and a notice to that effect is earnestly solicited.

Respectfully submitted,

Denis VINCENT

By: _____

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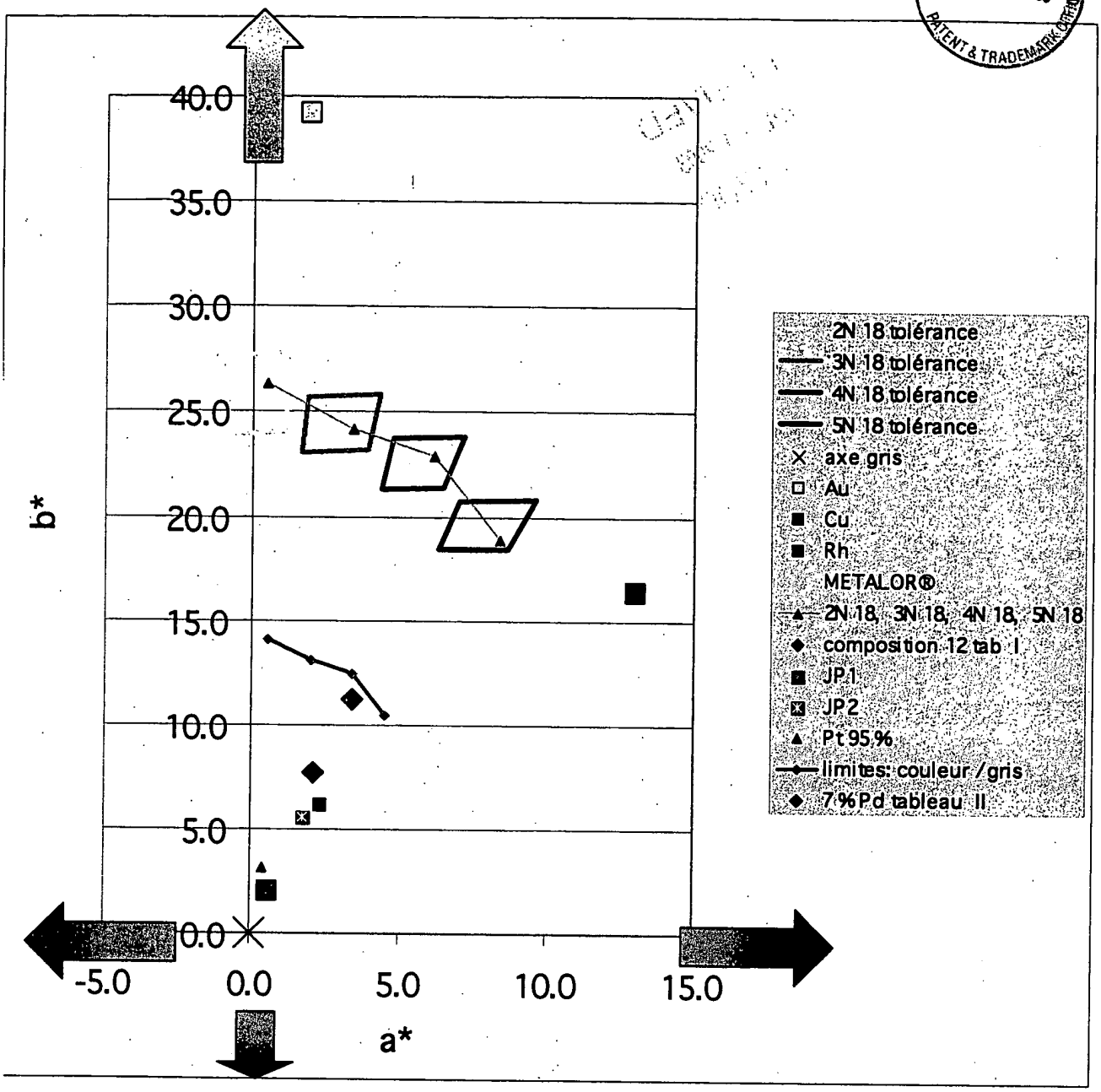
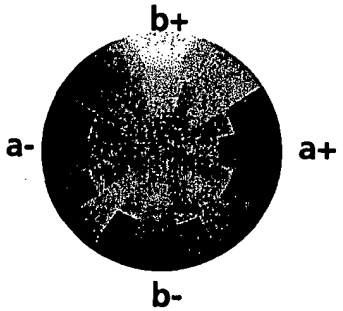
Telephone: (515) 288-9859
Telefax: (515) 288-4860




It is possible to measure the colours with optical spectrophotometer. The International Comity on Illumination CIE 1976 describes colc three numbers:

- L*, a* and b*. So called opponent colour coordinates.




Three axes permit to show in spatial representation any colour:

1. L, vertical axe: black, L* = zero; white, L* = 100.
2. Positive a* = red ; Negative a* = green.
3. Positive b* = yellow; Negative b* = blue.

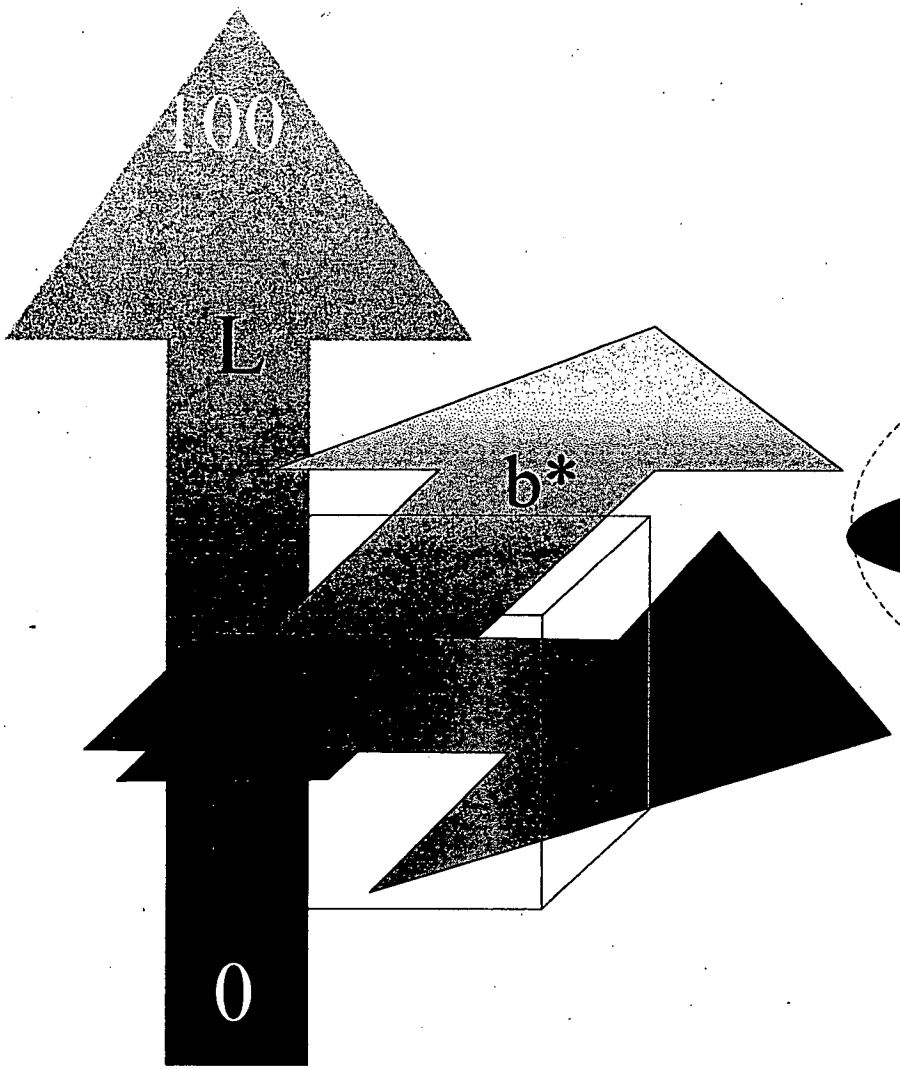
Two colours in this system could be compared with the following formula:
$DE = ( (a^*_2-a^*_1)^2 + (b^*_2-b^*_1)^2 + (L^*_2-L^*_1)^2 )^{1/2}$.
If DE < 1 not visible for a human eye.

The colour of coloured gold alloys is normalised; ISO 8654.
Six colours are normalised

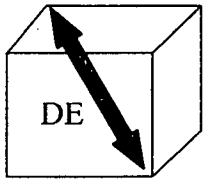
- For 14-Ct, the colours are: 0N green, 1N pale yellow.
- For 18-Ct, the colours are: 2N pale yellow, 3N yellow, 4N pink, and 5N red.

No normalisation exist about white or grey alloy. We consider as grey an alloy which have a colour nearer the rhodium colour than the normalised 18 carats coloured alloys

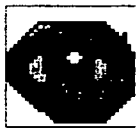
# CIELAB 1976

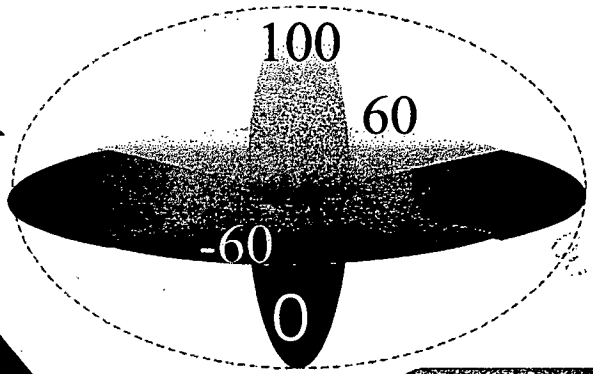


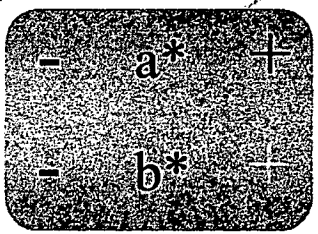

1 Unité

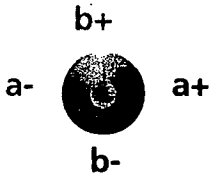



DE > 1 => visible





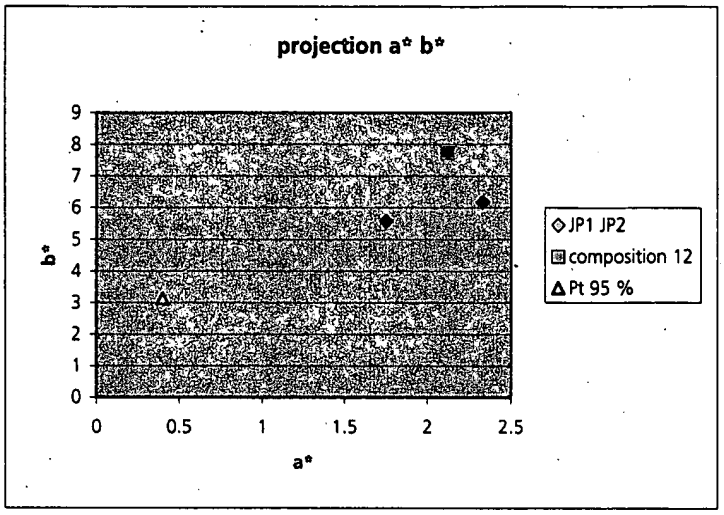



# Continuation appl. ser. N° 10/054,571

tableau 1 composition 12

| | Melting range | | colour | | | difference of colour DE with platinum alloy |
|---|---|---|---|---|---|---|
| | solidus | liquidus | L | a* | b* | |
| JP1 | 1060 | 1100 | 84.29 | 2.33 | 6.18 | 7.6 |
| JP2 | 1100 | 1160 | 83.7 | 1.75 | 5.58 | 7.8 |
| composition 12 | 1035 | 1115 | 79.87 | 2.12 | 7.75 | 12.1 |
| Pt 95 % | | | 91 | 0.4 | 3.13 | 0.0 |



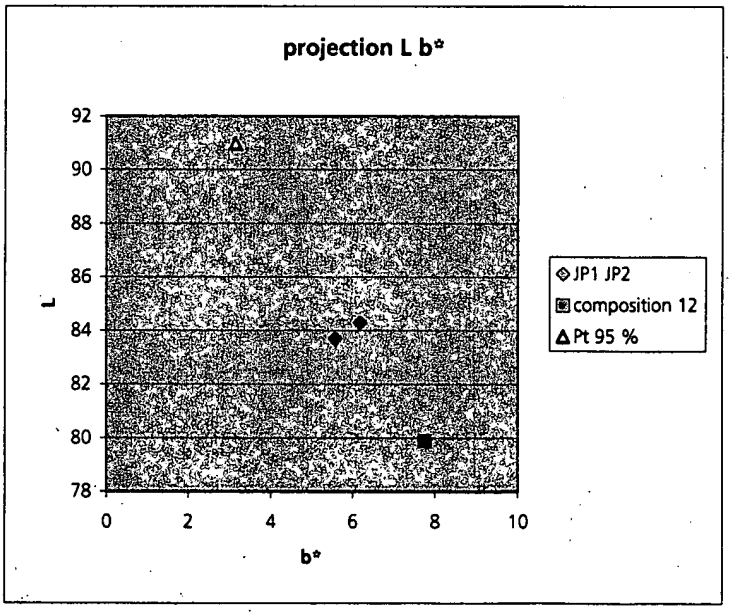
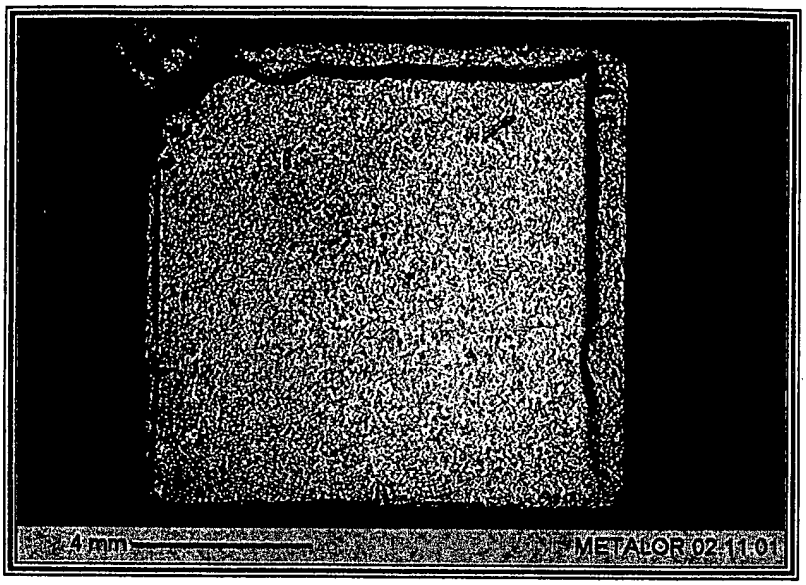



table 1 composition 12

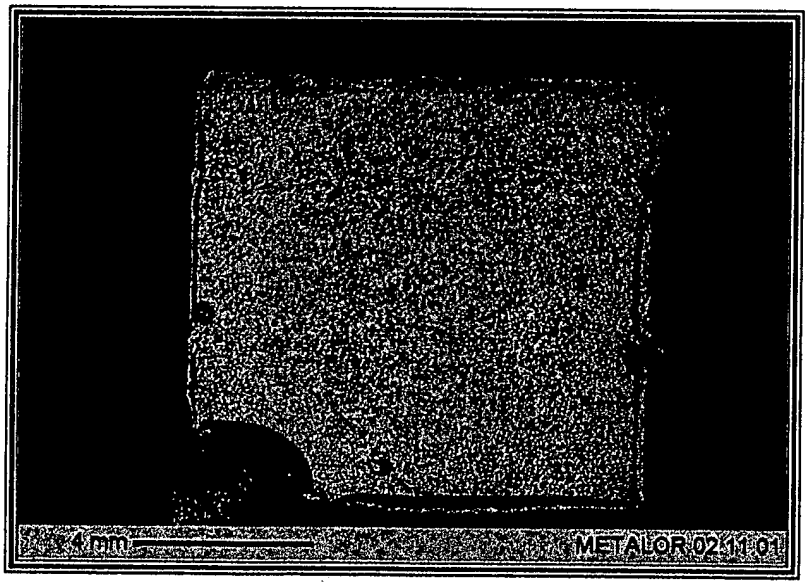
1




Au 75.1 ; Pd 13 ; Cu 10.039 ; In 1.5 ; Ga 0.35; Ti .001; Re 0.001

surface recto

2

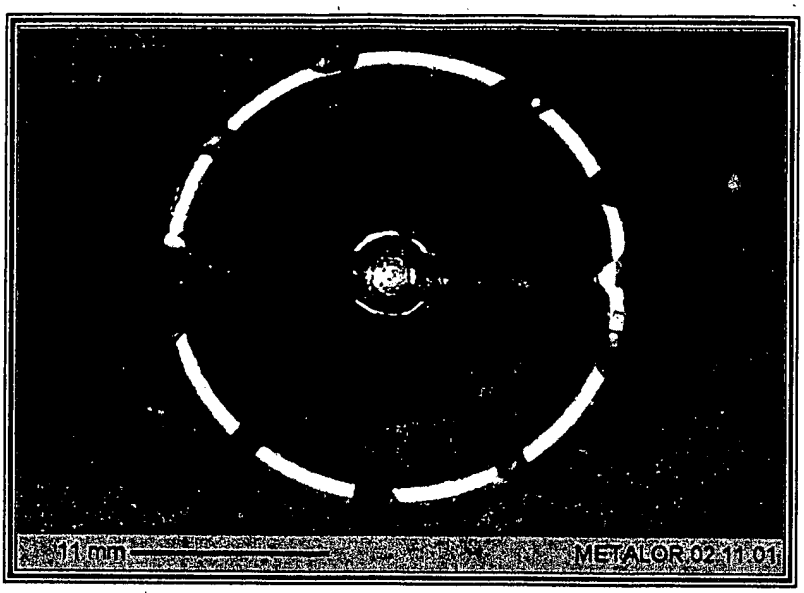



Au 75.1 ; Pd 13 ; Cu 10.039 ; In 1.5 ; Ga 0.35; Ti .001; Re 0.001

surface verso

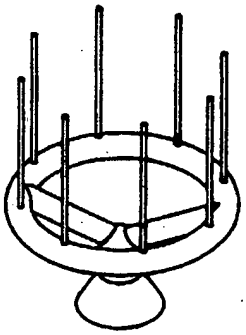
tableau 1 composition 12

3




arbre de coulée
casting tree

4



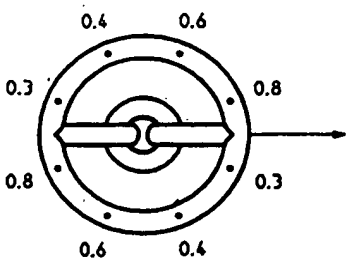
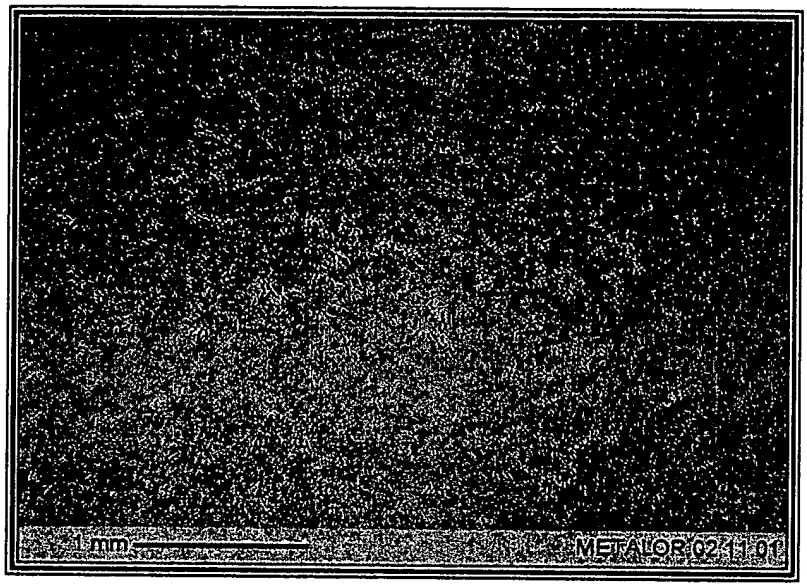


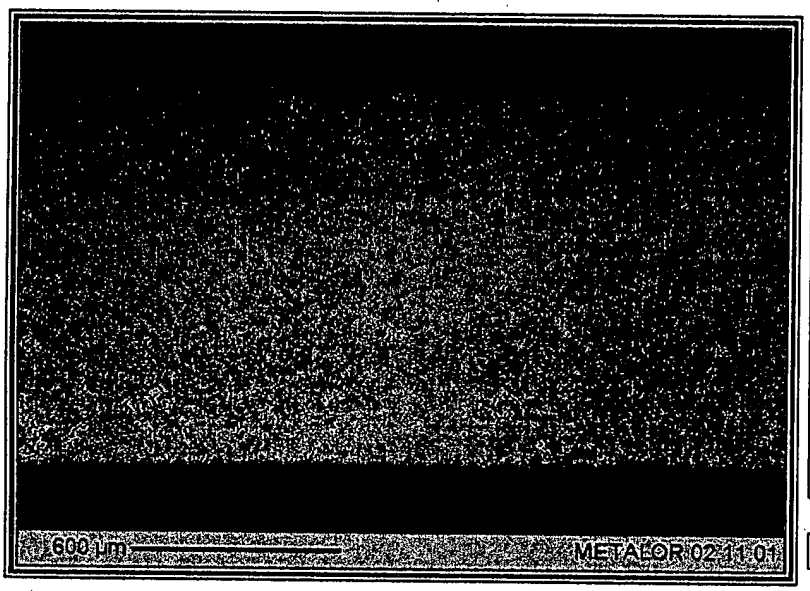
tableau 1 composition 12

5




metallography HV 191

6

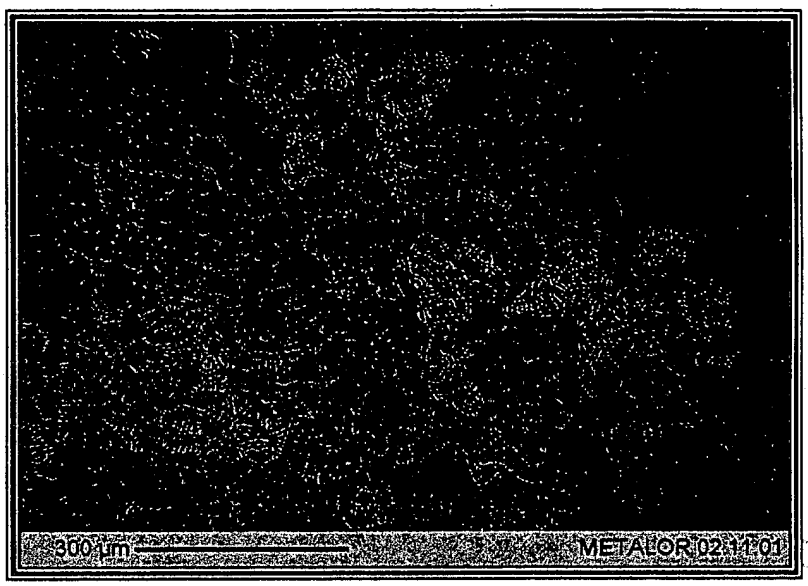



metallography

## Continuation appl. ser. N° 10/054,571

tableau 1 composition 12

**7**




metallography

**8**

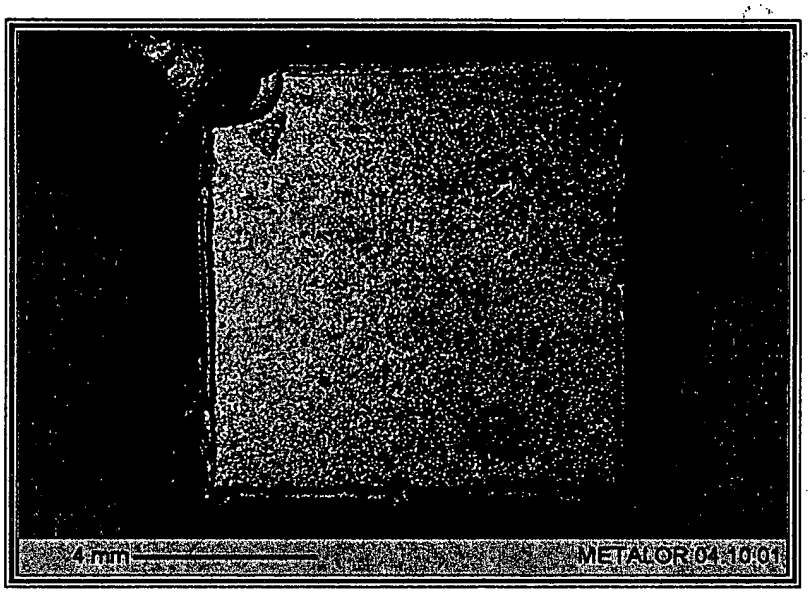

metallography

# Continuation appl. ser. N° 10/054,571

Patent Number JP9078160

JP1

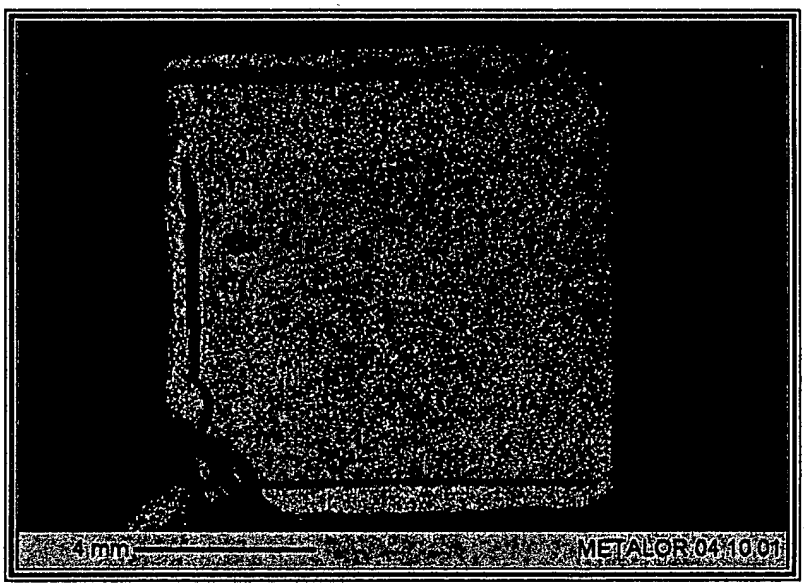
**1**




Au 75 ; Pd 12.5 ; Cu 12.5

Surface

**2**




Au 75 ; Pd 12.5 ; Cu 12.5

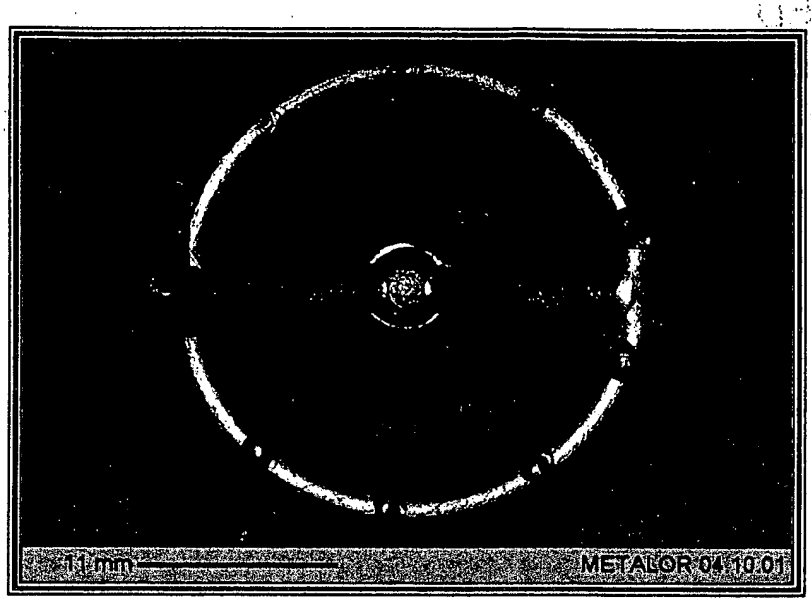
Surface

## Continuation appl. ser. N° 10/054,571

Patent Number JP9078160

JP1

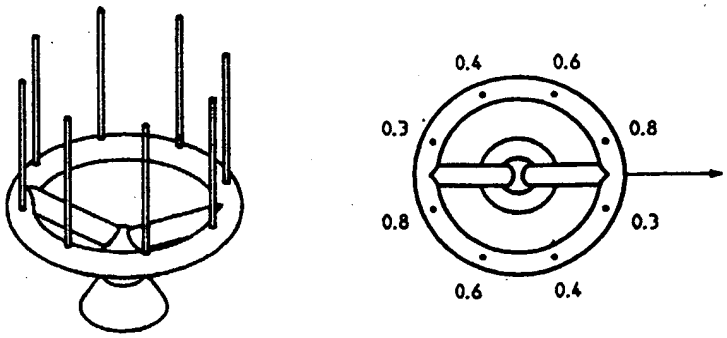
**3**




Au 75 ; Pd 12.5 ; Cu 12.5

Casting tree

**4**




Au 75 ; Pd 12.5 ; Cu 12.5

Casting tree

## Continuation appl. ser. N° 10/054,571

Patent Number JP9078160

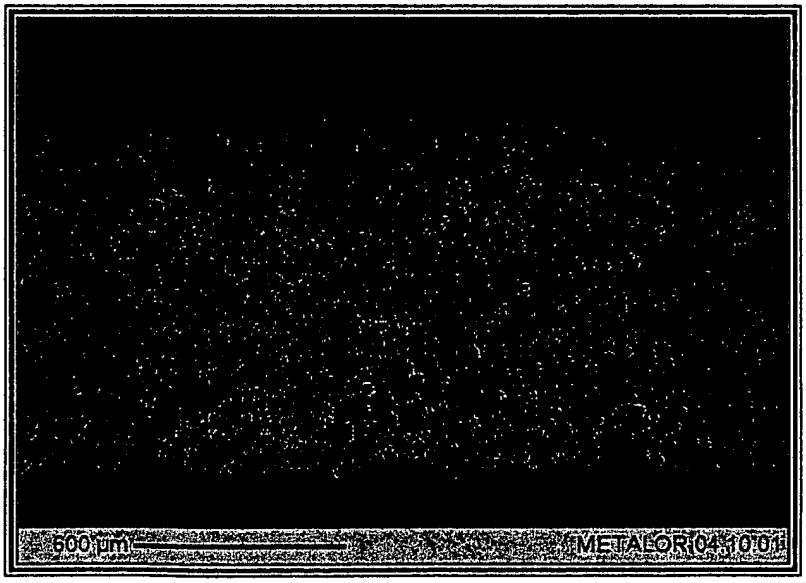
JP1

**5**


Au 75 ; Pd 12.5 ; Cu 12.5

metallography HV 138

**6**




Au 75 ; Pd 12.5 ; Cu 12.5

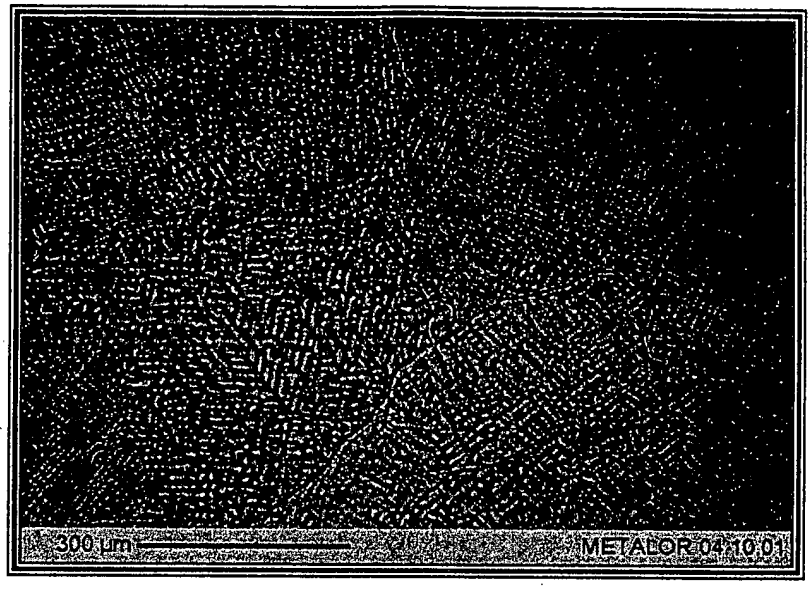
metallography HV 138

## Continuation appl. ser. N° 10/054,571

Patent Number JP9078160

JP1

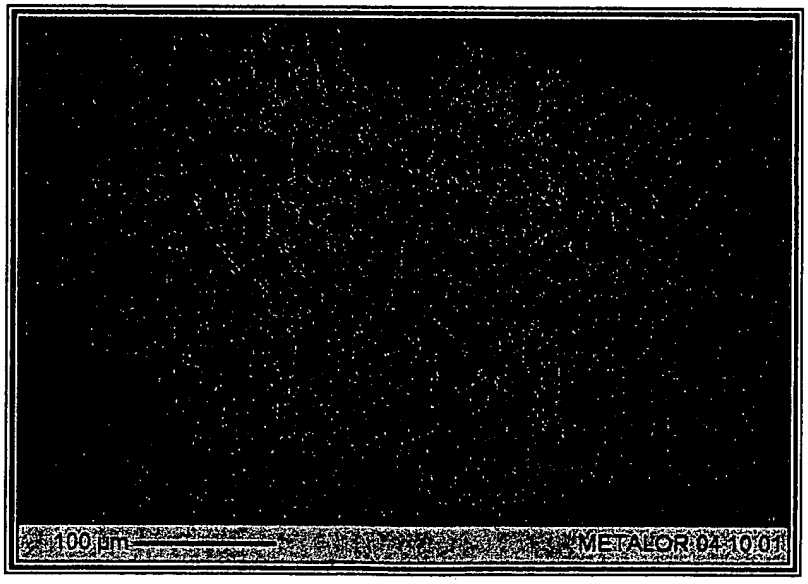
**7**




Au 75 ; Pd 12.5 ; Cu 12.5

metallography

**8**




Au 75 ; Pd 12.5 ; Cu 12.5

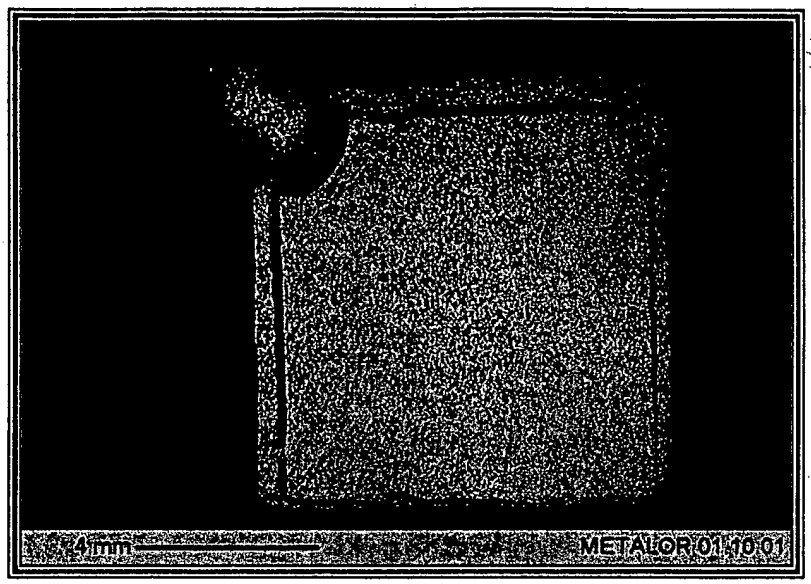
metallography

# Continuation appl. ser. N° 10/054,571

Patent Number JP9078160

JP2

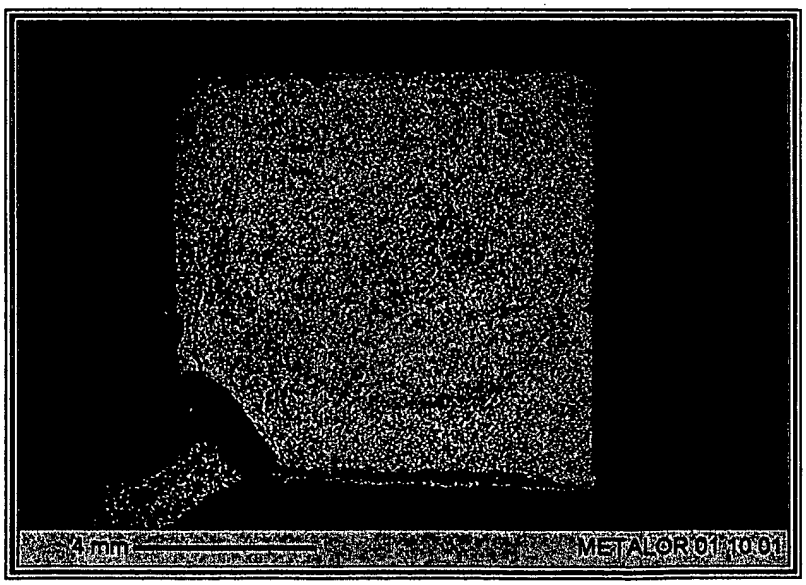
1




Au 75 ; Pd 15 ; Cu 10

surface

2




Au 75 ; Pd 15 ; Cu 10

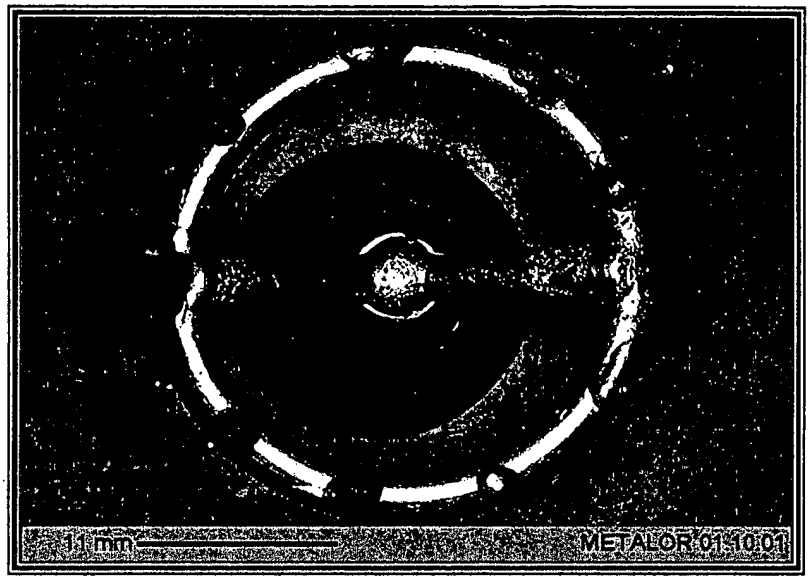
surface

# Continuation appl. ser. N° 10/054,571

Patent Number JP9078160

JP2

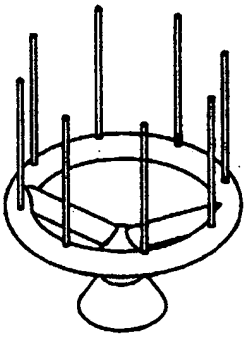
**3**

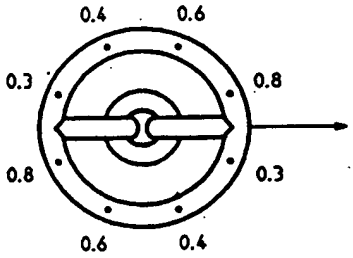



Au 75 ; Pd 15 ; Cu 10

casting tree

**4**






Au 75 ; Pd 15 ; Cu 10

casting tree

# Continuation appl. ser. N° 10/054,571

Patent Number JP9078160

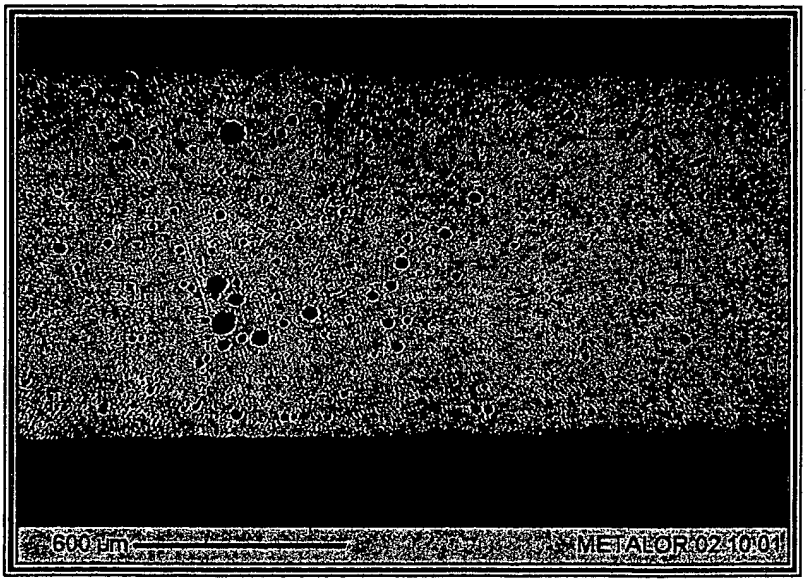
JP2

**5**


Au 75 ; Pd 15 ; Cu 10

metallography HV 129

**6**




Au 75 ; Pd 15 ; Cu 10

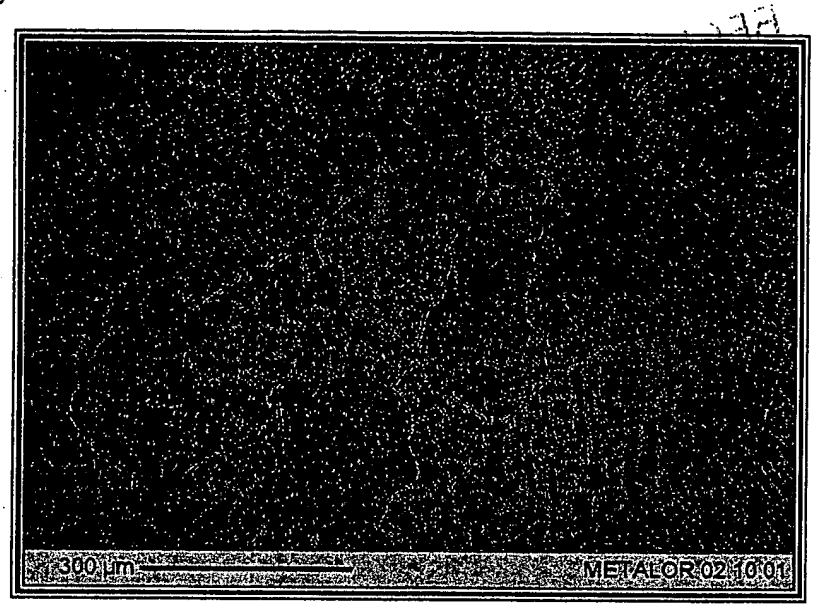
metallography HV 129

## Continuation appl. ser. N° 10/054,571

Patent Number JP9078160

JP2

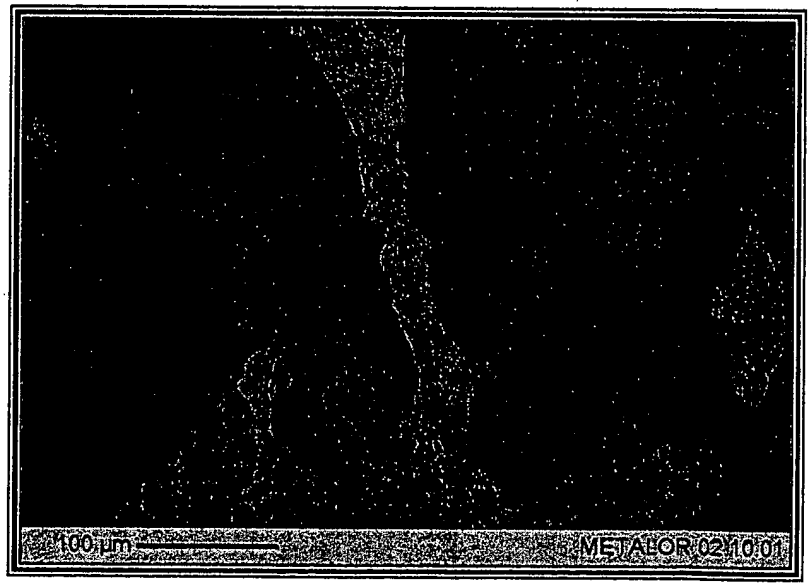
**7**




Au 75 ; Pd 15 ; Cu 10

metallography

**8**




Au 75 ; Pd 15 ; Cu 10

metallography

# PALLADIUM BLENDED WHITE GOLD ALLOY FOR PRECIOUS ORNAMENT

Patent Number: JP9078160
Publication date: 1997-03-25
Inventor(s): FUJIMOTO MASARU
Applicant(s):: TAZAKI SHINJIYU KK
Application Number: JP19950262545 19950913
IPC Classification: C22C5/02

## Abstract

PROBLEM TO BE SOLVED: To produce a Pd blended white alloy for precious ornament by alloying Pd and Cu into K18 gold by specified equivalent.
SOLUTION: K18 gold contg. 75% Au content is incorporated with Pd and Cu by >=10wt.% equivalent to produce a white gold alloy for ornament. This Au-Pd-Cu alloy has a white color similar to that of platinum, excellent in castability and extremely small in the generation of scuffing, fine splits or the like at the time of grinding, by which the Pd blended K18 white gold alloy for ornament excellent in machinability, hardness and strength can be obtd.

**[Patent formula]**

**[Claim 1]** A palladium blended white gold alloy for precious ornament obtained through the alloying of at least 10 wt. % palladium and at least 10 wt. % copper into gold alloy K 18 (Gold 18).
**[Claim 2]** A palladium blended white gold alloy for precious ornament according to claim 1 alloyed by said palladium and copper in equal proportion.
**[Detailed description of the invention]**
[0001]
**[Field of technical application]** The present invention relates to the white gold alloy used for producing brooches, etc., in particular, to the palladium blended white gold alloy whitened by adding palladium to K 18 gold containing 75% Au (Gold 18).
[0002]
**[Conventional art]** Gold is a metal, which loses its gloss in the course of time, and since its hardness and strength are low, usually it is alloyed with other metals. In particular, white gold K 18 with total content 75% Au (Gold 18) is used as a white metal material for precious ornament to substitute the expensive soft platinum having a high specific gravity. In recent years, due to its white color, white gold K 18, which is taking intermediate position between silver and platinum from the standpoint of price and specific weight, is gradually attracting attention as a material for precious ornament.
[0003] Depending on the main compound elements, white gold alloys can be subdivided into two groups: palladium element group (palladium blended white gold, Pd WG) and nickel element group (nickel white gold, Ni WG).
[0004] In contrast to common gold, white gold K 18 based on palladium element group (palladium blended white gold K 18, Pd WG K 18) contains palladium (Pd) and silver (Ag). As mentioned above, palladium is alloyed in order to add gloss to gold alloy. Silver is added in order to lower the melting point, as well as to reduce the specific weight of the entire gold alloy body.

[0005] White gold alloy K 18 has a practical drawback, which is similar to platinum related to its softness. Therefore, in order to increase hardness of the white gold alloy K 18, usually at least four metal elements are alloyed. Apart from palladium and silver, they are: copper (Cu) and nickel (Ni). The most common white gold alloy is palladium blended white gold alloy K18 (Pd WG 18).

[0006]

**[Drawbacks eliminated by the present invention]** The palladium blended white gold alloy K 18 consisting of said 4 elements has a drawback related to its poor grindability, which makes it difficult to obtain glossy gold surface. Therefore, the problem related to the generation of scuffing and fine splits in the near-surface area occurs at the time of grinding for obtaining precious ornament. When said scuffing and fine splits occur, it is extremely difficult to achieve gold gloss in the near-surface area all over the body. Essentially, precious ornament requires glossy metal surface, this is why the generation of scuffing and small splits results in considerable increase in labor and requires longer time in processing. Therefore, the manufacture of precious ornament products based on palladium blended white gold K 18 with a stable quality and at low price is extremely difficult.

[0007] Usually, in order to lower the melting point of the obtained gold alloy along with the whitening of the palladium blended white gold K 18, as well as to reduce the specific weight thereof, silver is added. The result of such alloying is the generation of scuffing and fine splits in the near-surface area at the time of grinding. On the contrary, if the composition ratio is reduced, which results in the reduction of the generation of scuffing and small splits, the problem related to the reduction of the whiteness level of the ornament, and local yellow color appears.

[0008] In addition, since the palladium blended white gold K 18 is obtained based on at least 4 elements, the problem related to the alloy solubility arises, which makes it difficult to handle the material due to its poor castability. Therefore, in case of casting, the risk of defective product increases, and the product output decreases, accordingly. As a result, cast product requires to be corrected and made over, so gross production of precious ornament based on the palladium blended white gold K 18 using casting becomes extremely difficult.

[0009] It is the objective of the present invention to offer a palladium blended white gold alloy K 18 for precious ornament, which is able to eliminate said drawbacks and to provide the effective control over the generation of scuffing or small splits at the time of grinding, as well as to facilitate the obtaining of white color in the near-surface area.

[0010] Another objective of the present invention is to offer a palladium blended white gold alloy K 18 for precious ornament with improved castability, along with excellent hardness and strength in comparison with the conventional palladium blended white gold K 18.

[0011]

**[Means for eliminating drawbacks]** For such purpose, the palladium blended white gold alloy K 18 for precious ornament offered by this invention is alloyed by at least 10 wt. % of palladium and at least 10 wt. % of copper.

[0012] It was verified that in case of alloying purely palladium, or palladium jointly with copper (Cu), instead of alloying silver into the gold alloy, the generation of scuffing or fine splits at the time of grinding can be prevented.

[0013] It is desirable that the said palladium and copper shall be added in equal proportion.

[0014]

**[Example of practical application]** The gold alloy for precious ornament offered by the present invention is gold alloy K 18 containing 75% Au (Gold 18), however in general, in order to guarantee a high quality, the total content of gold often is made somewhat higher by microquantity %, in which case in particular no problems occur. In order to obtain white color of the ornament it is necessary to add at least 10 wt. % palladium (Pd). The palladium blended white gold alloy containing by weight not less than 10% Pd provides better spreading characteristics. By adding at least 10 wt % copper (Cu) into the palladium blended white gold alloy containing by weight not less than 10 % palladium provides the improvement of machinability, hardness and strength of the alloy.

[0015] Accordingly, in case of adding about 15 wt. % palladium into the palladium blended white gold alloy, which is not alloyed with silver, scuffing or fine splits practically do not occur at the time of grinding.

[0016] By adding silver into conventional white gold alloy, a low melting point, along with an improved specific weight is provided, however, due to the adding of at least 10 wt % Cu into the palladium blended white gold alloy K 18 offered by the present invention, a low melting point, as well as an adequate specific weight is provided.

[0017]

**[Example of practical application]**

<Example 1> A palladium blended white gold alloy K 18 has been obtained using the traditional manufacturing method, wherein 12.5 wt. % Pd and 12.5 wt. % Cu have been added into gold with 75% Au content. The white gold alloy has been obtained having the theoretical specific weight value of 15.85. The white gold alloy was of white color

suitable for precious ornaments. In addition, the measured Vickers microhardness of the white gold alloy obtained was on average Hv 121, and the melting point was about 1250° C.

[0018] Figure 1 (a) shows the microphotograph of the surface of the obtained palladium blended white gold alloy K 18 (100 times enlargement), and figure 1 (b) presents the microphotograph of the same using polarizing filter. As clearly seen from both photographs, no scuffing or fine splits exist on the surface, and gold gloss in the near-surface area can be easily obtained. Furthermore, the only one casting defect in the form of a black point, which is usually called "blow hole" can be observed, which is absolutely not a problem, and can be neglected. In addition, the obtained palladium blended white gold alloy K 18 provides comparatively high castability, along with the improved hardness and strength, which makes it possible to be used for precious ornament.

[0019] <Example 2> The palladium blended white gold alloy K 18 has been obtained using the traditional manufacturing method, wherein 15 wt. % Pd and 10 wt. % Cu have been added into gold with 75% Au content. The white gold alloy has been obtained having the theoretical specific weight value of 16.04. The white gold alloy was of white color suitable for precious ornaments. In addition, the measured Vickers microhardness of the white gold alloy obtained was on average Hv 115, and the melting point was about 1350° C.

[0020] No scuffing or fine splits exist on the surface at locations of grinding of the obtained palladium blended white gold alloy K 18, and gold gloss in the near-surface area can be easily obtained. In addition, the obtained palladium blended white gold alloy K 18 provides a comparatively high castability, along with the improved hardness and strength, which makes it possible to use it for precious ornament.

[0021] < Comparative example> The palladium blended white gold alloy K 18 has been obtained using the traditional manufacturing method, wherein 18 wt. % Pd and 6 wt. % Cu have been added into gold with 75% Au content. Figure 2 shows the microphotograph of the surface of the obtained palladium blended white gold alloy K 18 (100 times enlargement, polarization filter used). As clearly seen from figure 2, no scuffing or fine splits exist on the surface, and excellent gold gloss can be obtained.

[0022]

Thus, since the palladium blended white gold alloy K 18 offered by the present invention, contains no silver, small generation of scuffing or fine splits, along with excellent gold gloss, can be provided. Furthermore, due to the improved hardness, strength, as well as castability, excellent results in mass production of precious ornaments can be obtained.

**[Brief description of drawings]**

[Figure 1] (a) shows the 100 times enlarged microphotograph of the surface of the obtained palladium blended white gold alloy, and figure 1 (b) presents the microphotograph of the same using polarizing filter.

[Figure 2] shows the 100 times enlarged microphotograph of the surface of the obtained palladium blended white gold alloy using polarization filter as a comparative example.

[Figure 1] Drawing substituting photograph (color)

(a)

(b)

[Figure 2] Drawing substituting photograph (color)